

[54] APPARATUS FOR GENERATING A HIGH VOLTAGE

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[57] ABSTRACT

An apparatus for generating a high voltage which includes a transformer, a rectifying circuit connected to the transformer, a high voltage output terminal connected to the rectifying circuit, a foamed insulator molded into the space between the transformer and the components of the rectifying circuit with the exception of the high voltage output terminal, and a container insulated by the foamed insulator from the high voltage components and electrically grounded.

6 Claims, 6 Drawing Figures

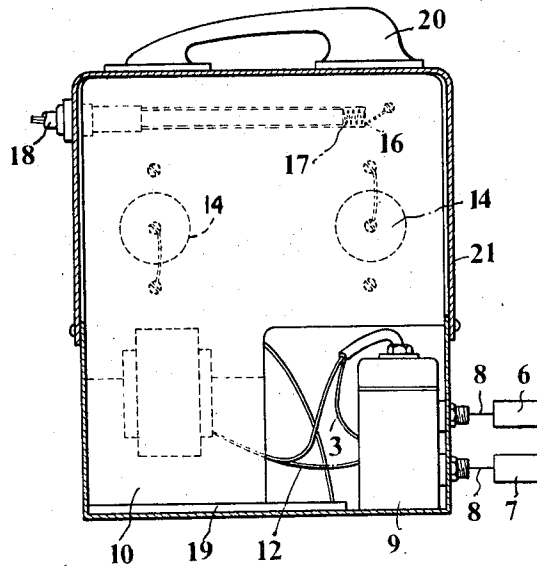


FIG. 2

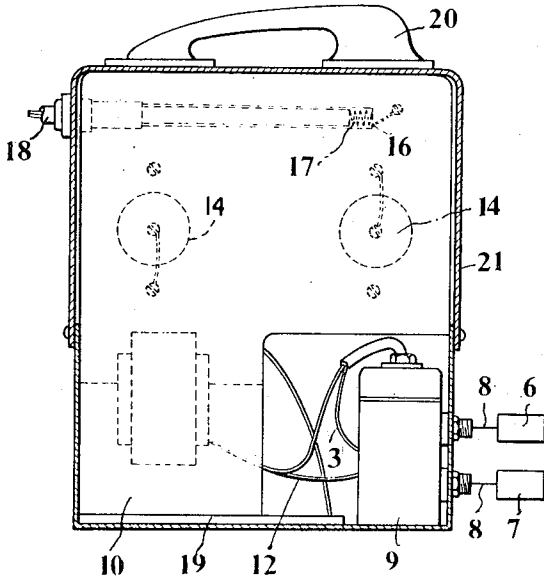


FIG. 1

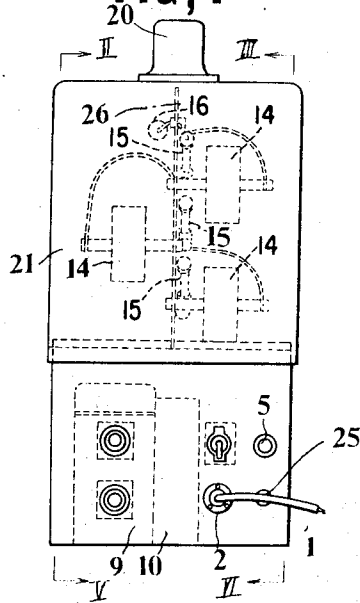
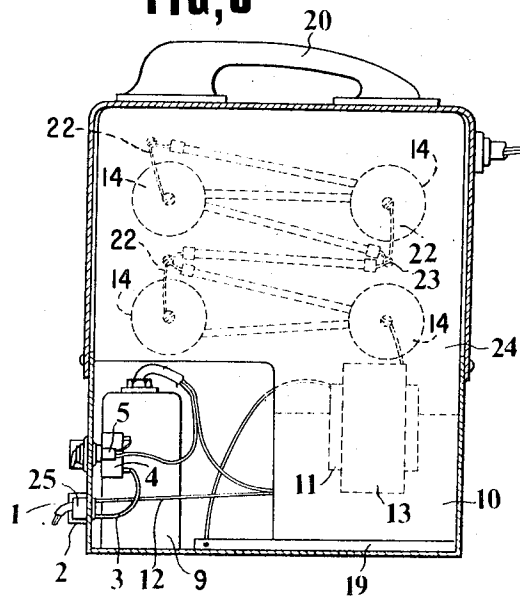


FIG. 3

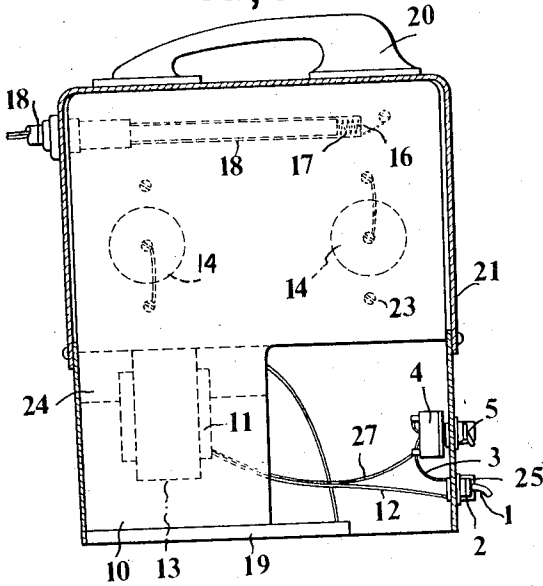


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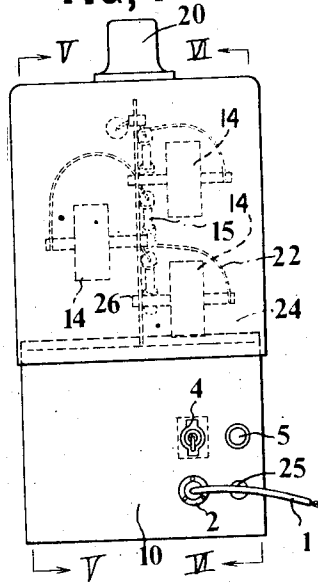
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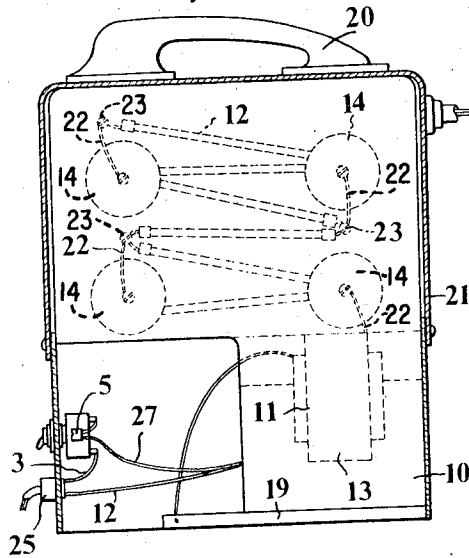
FIG, 5



FIG, 4



FIG, 6



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APPARATUS FOR GENERATING A HIGH VOLTAGE

BACKGROUND OF THE INVENTION

This invention relates to an apparatus for generating a high voltage and more particularly to improvements in an apparatus for generating a high voltage by filling the space between the high voltage components and parts with a foamed insulator.

In order to insulate the high voltage in conventional high voltage generating apparatus, the transformer, rectifier, capacitor and resistor are either contained within an insulating oil or are molded with a high voltage solid insulating resin. If an insulating oil or liquid is used to insulate the high voltage components in the high voltage generating apparatus, the generating apparatus will be too heavy to transport portably and must be sealed tightly so as to prevent the insulating liquid from leaking. If the solid insulating resin is used, the apparatus will be heavy and expensive, since most conventional solid insulators are heavy and expensive.

In the use of high voltage generating apparatus for electrostatic coating and particularly for electrostatic painting, for safety it is necessary that the high voltage be applied to the charging electrodes of the coating apparatus only while the coating material is sprayed onto the substrate. This is desirable because most solvents used in painting and coating compositions are volatile and highly combustible when subjected to an electric spark discharge. Moreover, by applying the high voltage to the electrodes only during the coating operation, the chances of subjecting the operator to an electric shock is reduced. The application of high voltage only during paint spraying is particularly necessary when a hand spray paint gun is used and the operator could easily be injured by fire or shock. Additionally, in a hand spray gun, it is desirable that the high voltage generating apparatus be portable, which requires that it be compact and light in weight.

In high voltage generating apparatus for electrostatic spraying, there generally exists four ways of stepping up the standard commercial power to a desired level. First, the commercial power which is generally about 50 or 60 hertz may be stepped up by a transformer and then rectified to direct current. Second, the commercial power may be stepped up by a transformer to one-half the above voltage and then stepped up to full voltage by rectifying with a voltage doubler rectifier using a capacitor to provide direct current of the desired voltage level. A third way of stepping up the standard commercial power to a desired level is by using a transformer having a step-up ratio which is less than that in each of the above methods, so that the rectifiers and the capacitors are divided into several stages, and thereafter the power is rectified to direct current. The power level is then further stepped up by use of such conventional systems as the "Cockcroft" or "Walton" type systems. Fourth, the commercial power may be stepped up by first converting the power into a voltage of high frequency, such as 15 kilohertz, and then rectifying and stepping up this high voltage by utilization of such conventional systems as the "Cockcroft" or "Walton" type systems.

Though the above first method is suitable for a high current load and the other three methods are suitable for low current loads, the prior art apparatus for each is still too heavy to provide a portable and hand-operated electrostatic spray gun.

SUMMARY OF THE INVENTION

Accordingly, one object of this invention is to provide a new and improved unique high voltage generating apparatus which is not only portable, compact and light, but which is less expensive to manufacture.

Another object of the subject invention is the provision of a new and improved high voltage generating apparatus which utilizes a light weight insulator of foamed material between the components.

Still another object of the present invention is the provision of a new and improved high voltage generating apparatus which does not require a sealed container.

One other object of the subject invention is the provision of a new and improved high voltage generating apparatus which utilizes a light weight insulator of foamed material to provide a light weight and portable hand operated electrostatic spray gun.

Briefly, in accordance with one aspect of the present invention, these and other objects are attained by the provision of an apparatus for generating a high voltage which uses a light weight and solid foamed insulator which fills the space between the high voltage components and the container of the apparatus and thereby lightens the weight of the apparatus and does not require the structure to be sealed.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily apparent as the same becomes better understood by reference to the following detailed description when taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a front view of one embodiment of the high voltage generating apparatus constructed in accordance with the present invention;

FIG. 2 is a sectional view of the apparatus taken along the line II—II in FIG. 1;

FIG. 3 is a sectional view of the apparatus taken along the line III—III in FIG. 1;

FIG. 4 is a front view of an alternative embodiment of a high voltage generating apparatus constructed according to the present invention;

FIG. 5 is a sectional view of the apparatus taken along lines V—V in FIG. 4; and,

FIG. 6 is a sectional view of the apparatus taken along the lines VI—VI in FIG. 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, and more particularly to FIGS. 1 through 3, wherein one embodiment of the apparatus constructed in accordance with the present invention is shown as having a cord 1 which includes a first line 3 and a second line 12 that are connected at one end to an external source of electric power (not shown). The other end of the first line 3 is connected through a connector 2, a power switch 4 and a fuse 5 to both a hand operated painting machine 6 and a source of compressed air 7 by way of an air-flow valve switch 9. The painting machine 6 and source of compressed air 7 are connected to the air-flow valve switch 9 by means of a pair of hoses 8. The air-flow valve switch 9, which is connected to one end of a primary winding 11 of a transformer 10, operates in response to the air-flow produced by triggering the hand operated painting machine 6. The other end of the primary winding 11 is connected to the second line 12 of the cord 1 which, as explained above, is connected to the external source of power.

The secondary winding 13 of the transformer 10 is connected through one or more capacitors 14 and rectifiers 15, such as of the selenium type, in an arrangement such as in the "Cockcroft" and "Walton" type systems, to an output terminal 16. The output terminal 16 is connected to a spring 17 and then to the charging electrodes (not shown) of the hand operated painting machine 6 through a cable 18. The base of the transformer 10 is connected to an electroconductive chassis 19 which is, in turn, connected to an electroconductive container 21. The container 21 has a handle 20 conveniently attached thereto for enabling the easy carrying thereof.

The capacitors 14, rectifiers 15, transformer 10 and high voltage wiring lines 22 connected between these components and fixing screws 23 are each electrically insulated from the container 21 by being molded with a foamed filler 24 therebetween such, for example, as a foamed polyurethane resin.

In the operation of the apparatus described above, a high voltage direct current is first applied between the cable 18 and the container 21. Now, since the container 21 is conductive through a grounded terminal 25, an electric field will be established between a grounded article being painted and the charging electrodes of the spray gun, which is also connected to the cable 18, so that the desired electrostatic painting can be conventionally accomplished.

In order to fill the space between the high voltage components and the container 21, the transformer 10, rectifiers 15, capacitors 14, fixing screws 23, and wiring lines 22, with foamed filler, the components may be first mounted on an insulating supporting member 26 prior to assembly thereof within the container 21 and then the foam is molded around the components to a predetermined shape using a removable mold. The wiring lines of the molded supporting member 26 are then electrically connected to the appropriate parts within the container 21 and are inserted therein.

It should be understood, however, that the invention is not so limited and that the process for filling the foamed filler between the high voltage components and the container 21 may be achieved by filling the foamed filler therebetween after the high voltage components and other components are wired and are contained within the container 21.

It should also be understood that the electrically insulating foamed filler is not limited to polyurethane, but may be of any substance which has a low specific weight, and is heat resistant, burn resistant, and voltage resistant.

It should also be understood that in order to prevent any leakage current in the wiring between the transformer, which may have an output voltage such, for example, as of 10 kilovolts and a direct current output voltage after rectification, such, for example, as 60 kilovolts, and the components, that the wiring therebetween may be insulated before the foam is filled therein.

It should further be apparent that while an air-flow valve switch 9 has been shown for switching the high voltage supply to the transformer 10 in response to the change of air flow produced when the trigger of the spray gun 6 is operated, that the subject invention is not so limited and that the external power may be supplied or shut off by an electric switch such, for example, as a microswitch or the like, which may be provided within the spray gun 6, and operated when the trigger thereof is pulled.

This alternative arrangement is more clearly shown in reference to FIGS. 4 through 6, wherein the air-flow valve switch 9 is eliminated.

In particular, the alternative embodiment of FIGS. 4 through 6 shows a cord 1 which again includes a pair of lines 3 and 12 which are connected to an external source of electric power (not shown). The line 3 is here connected through a connector 2 to a power switch 4, and a fuse 5 and then directly to the primary winding 11 of the transformer 10 by way of a wiring line 27. Line 12 is again connected to the other end of the primary winding 11 of the transformer 10.

The secondary winding 13 is connected through one or more capacitors 14 and rectifiers 15, such as of the selenium type, in an arrangement such as in the "Cockcroft" or "Walton" type systems, to an output terminal 16. The output terminal 16 is connected to a spring 17 and then to the charging electrodes (not shown) of the painting machine 6 through a cable 18.

The base of the transformer 10 is connected to an electroconductive chassis 19 which is, in turn, connected to the electroconductive container 21. The container 21 again has a handle 20 attached thereto for enabling the easy carrying thereof.

The capacitors 14, rectifiers 15, transformer 10 and high voltage wiring lines 22 connected between the components and fixing screws 23 are again electrically insulated from the container 21 by being molded with a foamed filler 24 therebetween.

In operation of the apparatus described above with reference to FIGS. 4 through 6, a high voltage direct current is again first applied between the cable 18 and the container 21. Now, since the container 21 is conductive through a grounded terminal 25, an electric field will be established between a grounded article being painted and the charging electrodes of the spray gun 6 which is also connected to the cable 18 so that the conventional electrostatic painting may be readily accomplished.

It should also be understood that in order to prevent any leakage current in the wiring between the transformer, which may have an output voltage such, for example, as of 12 kilovolts and a direct current output voltage after rectification such, for example, as 70 kilovolts, and the components that the wiring therebetween may be insulated before the foam is filled therein. Good results are obtained when the foamed filler has a specific weight of 0.029.

One necessary requirement for the foamed filler is that the foam cells be closed and independent with each other and preferably not be continuous in order to withstand the voltage thereacross.

It should be further understood that the present invention is not limited to a particular type of rectifying system or rectifier and, additionally, if no trouble exists at the point of voltage resistance, then the transformer need not be disposed within the same space as the rectifying circuit and this space may be filled with foamed filler. However, under such conditions, it is preferable to use a cold cathode of selenium having small calorific power or a silicon semiconductor.

It should now be apparent from the foregoing description that the foamed insulator may be readily removed so that any defective components may be easily replaced and refilled with a new foamed insulator. This allows for rapid maintenance in comparison with conventional apparatus which uses heavy solid insulating fillers.

It should also now be apparent that since the high voltage circuit of the present invention is insulated and filled with a foamed insulator, that the same is not only compact and light in weight, but does not require sealing as is necessary for conventional apparatus using liquid insulators.

Moreover, it should be understood that the foamed insulator of the present invention will readily absorb any shock due to vibration, thus enabling the realization of a portable high voltage generating apparatus.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. Apparatus for generating a high voltage, comprising:
 - a transformer,
 - a rectifying circuit means including a plurality of components therein and connected to said transformer,
 - a high voltage output terminal connected to said rectifying circuit means,
 - a foamed insulator molded into the space between said transformer and the components of said rectifying circuit means, and,
 - a container insulated by said foamed insulator from said high voltage components and electrically grounded, said high voltage being connected with an electrostatic spraying system which includes a spray gun having charging electrodes therein.
2. Apparatus for generating a high voltage as set forth in claim 1, wherein said container is made conductive through a rounded terminal whereby an electric field is formed between the grounded article being sprayed and the charging electrodes of said spray gun.
3. Apparatus for generating a high voltage as set forth in claim 1, wherein said insulator is a foamed polyurethane resin.
4. Apparatus as set forth in claim 3, wherein said insulator is a closed cell foam which is non-continuous.

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5. Apparatus for generating a high voltage as set forth in claim 1, wherein said transformer is not disposed within the same space as said rectifying circuit means and wherein said rectifying circuit means includes a rectifier which is a cold cathode of selenium.

6. Apparatus for generating a high voltage as set forth in

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claim 1, wherein said transformer is not disposed within the same space as said rectifying circuit means and wherein said rectifying circuit means includes a rectifier which is a semiconductor.

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